The Central Office for Astronomical Telegrams. By Professor A. Krueger.

(*Extract from a letter to the President.*)

I have been often surprised that the Central Office for Astronomical Telegrams has only one subscriber in England, while in France we have 5, in Spain and Portugal 3, in Italy 5, in Germany 12, in Austria 4, in Switzerland 3, in Russia 12, in Scandinavia 4, and in Holland and Belgium 4.

Perhaps you would bring the matter before a meeting of the R.A.S. The yearly contribution for those who do not desire telegrams of discoveries of minor planets is at present 2*l.*, or including minor planets, 3*l.*

As the number of subscribers increases, the yearly subscription will be reduced, by reason of the necessary expenses of management being divided among a greater number.

New Arrangement of Electrical Control for Driving Clocks of Equatorials. By Sir Howard Grubb, F.R.S.

In a paper read before this Society last spring I mentioned that it appeared to me likely that the best system for obtaining accurate clock-driving, and that most suitable for photographic work, would be found to be a combination of Dr. Gill's as applied to Lord Crawford's 15-inch equatorial, and mine as applied to Mr. Roberts's equatorial.

I have since worked this out, and the driving apparatus I exhibit to-night (which is intended for the stellar photographic instrument of the Mexican, Chapultepec, Observatory) is the result.

There is nothing novel to remark on in the clock itself except the governor.

In Dr. Gill's control, as applied to the Earl of Crawford's telescope, and in my earliest form, the correction was applied to the governor by an increase or decrease of friction, and it was therefore desirable to keep down the *vis inertiæ* of the governor, but as, in this form, the correction is applied in a totally different manner, it is permissible to employ a very heavy, quick-moving governor, with a corresponding increase of *vis inertiæ*, and this has, as can easily be understood, great advantages in many ways, more particularly in the obtaining of great smoothness of motion.

In this particular governor, instead of balls I use a brass ring loaded with lead, and cut into eight segments; and in addition to gravity, springs are applied, one to each segment, tending to supplement the force of gravity; by which arrangement the speed of the governor is increased from 90 to 135 revolutions,

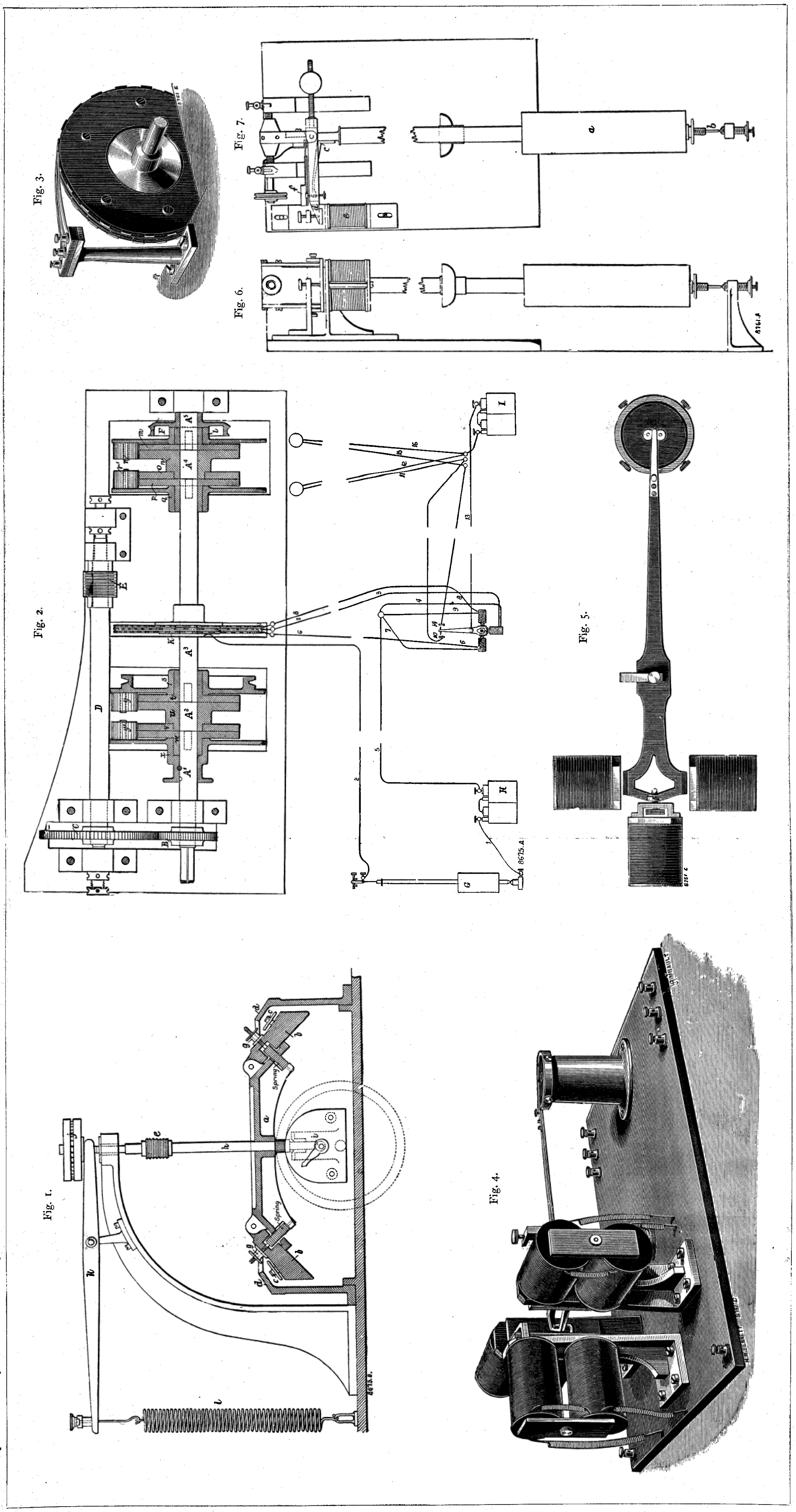


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Spring
Spring

and the *vis inertiæ* is represented by some 10,000 foot-pounds per minute.

As the great weight of this governor would cause a considerable amount of friction in the toe bearings, a pair of hardened steel discs, between which a set of bicycle balls roll, are introduced at upper end of spindle. See fig. 1, Plate 2.

Again, to reduce the number of wheels, and consequent errors between the governor and the screw spindle, the governor spindle is furnished with a screw, *e*, on upper end, which gears directly into a wheel, *f*, fig. 2, on counter spindle of screw shaft.

This is a suggestion of Dr. Gill's.

The system of control may be conveniently divided into two distinct parts: first, the *detector*; and, second, the *corrector*; and this second part, the *corrector*, is again divided into the *accelerator* and the *retarder*.

The detector is seen at K, fig. 2, and also in perspective in fig. 3. It consists of three discs of brass, separated by discs of ebonite on which three metallic wipers rub, the brass discs being so cut on edge that the central one presents a set of twenty sharp contact teeth, and each of the others twenty contact spaces separated by spaces of no contact.

The three discs, which revolve together in twenty seconds, are so arranged that no two contacts take place at the same time.

Any current sent through this wheel and contacts will be sent into one or other of the three wipers, whichever is in contact at the exact moment the current passes.

From these three wipers the current is sent into one or other of the three electro-magnets of the relay (figs. 4 and 5), which may be placed at any distance.

If the current passes at the moment the centre disc with its short sharp contact is under its wiper, it is directed into the central electro-magnet of the relay (figs. 4 and 5), which tends to keep the lever central, and in contact with neither of the platinum contacts at the other end.

If the current passes at any other moment, it is directed into one or other of the side electro-magnets, and the lever of relay is driven to one side or another, and makes contact, which brings into play the accelerator or retarder of the correcting apparatus.

The correctors consist of two pairs of differential wheels, of the ordinary type of those used in my equatorials for slow motion in R.A.

The counter-shaft is discontinuous, being cut across between each pair of differential wheels. On the adjacent ends of this discontinuous shaft toothed wheels, *n m*, fig. 2, are attached, cut with a difference of one tooth in forty. Across both wheels gears a pinion, *r* or *r'*, carried on a stud on a plate or disc, itself free to move round the shaft.

In the normal condition of working, the whole of the arrangement revolves together, acting as a clutch, but if the disc carrying the pinion be stopped the motion is transmitted

from the wheel m to n *through the pinion*, and a difference of rate + or − occurs according as the driver or the driven wheel has the greater number of teeth. The periphery of the disc is cut into fine teeth, and the armature of an electro-magnet suitably placed is provided with a comb, which engages in these fine teeth and stops the disc whenever that particular electro-magnet has the current directed into it by the relay above described.

The action of this apparatus is as follows: A pendulum beating seconds, shown diagrammatically at G, fig. 2, and more in detail in figs. 6 and 7, closes a circuit once every second, and allows a current from the battery H to flow through the wires 1 and 2 to the central contact ring of the detector. If the telescope is being driven properly this closing of the circuit by the pendulum will be synchronous with the passage of one of the central series of peripheral contact pieces under the contact spring connected to the wire 3, and the current will thus follow the circuit 1, 2, 3, 4, and 5, bringing into action the central electro-magnet of the relay. Referring to figs. 4 and 5, it will be seen that this relay has a vibrating lever, which, when acted upon by the armature of the central electro-magnet, is held in the central position, the effect of its being so held being that no current is transmitted by the relay, and the driving of the telescope is not interfered with. Let us suppose, however, that at the instant the pendulum closes its circuit the telescope is slightly ahead of its proper position. In this case, instead of one of the central series of contact pieces being under the contact spring when the circuit is closed, one of the right-hand series will be under *its* spring, and the circuit will follow the wires 1, 2, 8, 9, 5, bringing into operation the right-hand electro-magnet of the relay, and drawing the lever of the latter over to one side. The effect of this movement of the lever is to close a connection at 10, and cause a current from the battery I to traverse the circuit 13, 10, 11, 12, and bring into action the magnets actuating the clamp which will hold the disc q of the retarder, thus retarding the motion of the telescope. On the other hand, if the telescope falls behind its proper rate, the current transmitted by the pendulum will traverse the circuit 1, 2, 6, 7, 5, the lever of the relay will be drawn over to close the circuit at 14, and the current from the relay battery I will traverse the circuit 13, 14, 15, 16, and bring into action the clamp operating the accelerating disc l.

The shaft A makes one revolution in 20 seconds, so that during each revolution twenty correcting currents are transmitted by the controlling pendulum. The proportions of the accelerator and retarder are also such that the alteration made in the driving of the telescope equals $\frac{1}{40}$th of the time during which the accelerator or retarder is put into operation. Thus, if the driving of the telescope from any cause becomes $\frac{1}{20}$th of a second in arrear, the controlling apparatus will correct the error

by bringing the accelerator into action for a period of 2 seconds, and so on.

The seconds pendulum by which the control is exerted is shown in detail by figs. 6 and 7. It may be a mercurial or any other type of compensated pendulum, and its bob *a* carries a fine point *b* which at each oscillation closes an electric circuit by passing through a globule of mercury, and so transmits the current to the detector gear already described. The mode of driving the pendulum is as follows: The upper part of the pendulum rod carries a light arm *c*, which as the pendulum oscillates from right to left picks up the weight *f*, shown in fig. 7 as resting on the supporting lever *d*. If the latter remained in the position there shown the arm *c* would simply redeposit the weight at the same level during the reverse oscillation of the pendulum and the latter would receive no impulse. But just before the weight can be thus redeposited the closing of the electric circuit by the pendulum brings into action the electro-magnet *e*, which, attracting the armature, draws down the lever *d*. On the current ceasing and the armature being released, the lever *d* is restored by its counterweight to the position shown in fig. 7, of course relieving the arm *c* of the load *f*. The effect of this is that the weight *f* remains resting on the arm *c* for a longer arc while descending than while ascending, and hence the pendulum receives the necessary impulse.

Slow Motion in R.A.—Besides the ordinary slow motion in R.A. it is purposed to provide a very delicate slow motion, specially suited for correcting, for refraction, &c.

This is accomplished by another set of correctors similar to those above described, and acted on by another pair of electro-magnets (shown at the other end of the counter-shaft in fig. 2).

These electro-magnets are excited from a commutator held in the hand of the observer while watching a star in the guiding telescope.

If he finds a correction necessary, a pressure on one key of the commutator produces a temporary acceleration of $\frac{1}{40}$th part, and a pressure on the other a retardation to the same amount.

This arrangement acts absolutely without any backlash or jerk to instrument.

Note.—It is necessary to employ a second set of correctors for this, for if the same set as that actuated by the automatic control were used, the detector would treat the hand correction as an error and proceed to undo it again.

It is well to mention, in case it may appear that the arrangement shown in fig. 2 is complicated, that in the normal state of things the counter-shaft, with all its correctors, detectors, &c., revolves as one solid piece, and it is only when any correction has to be made that any of this work comes into action.

Slow Motion in Declination.—Every telescope-worker knows how impossible it is to get a declination slow motion absolutely free from "loss," unless by the so-called German form, in which

a screw acts against a long pliable spring, to which there are serious objections. In the arrangement shown in figs. 8 and 9 the advantage of having all backlash taken up by a spring is retained, while a very stiff spring can be employed. In figs. 8 and 9, *a* is

Fig. 8.

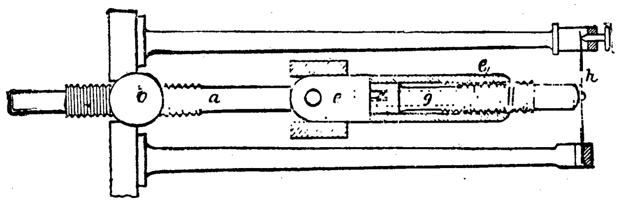
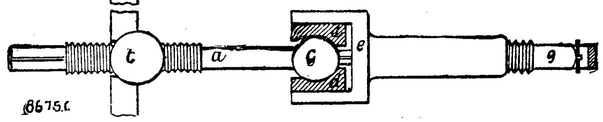


Fig. 9.



the screw by which the adjustment is made, this screw working through a nut *b*, and having a spherical end *c* bearing in the crosshead *d*. Thus, as the screw is turned the distance between the nut *b* and crosshead *d* is varied. At *h* is a short stiff spring, which by means of the screw *g* and sleeve *e* exerts a pressure on the crosshead *d*. At *f* is a square prolongation of the screw *a*, which enters a correspondingly squared hole in the screw *g* so that the latter turns with *a*. But whereas the screw *a* has a right-hand thread, that of the screw *g* is left-handed, so that every increase of distance between the nut *b* and crosshead *d* is accompanied by an equal decrease in the length of the combination *g e*, and thus the pressure exerted by the spring remains constant, whatever may be the position of the crosshead *d*.

Description of a New Observatory for a 3-foot Reflector.
By Edward Crossley.

On the removal of Mr. Common's 3-foot reflector from Ealing the ingenious wooden house, or observatory, designed by Mr. Common was also re-erected at Halifax. The situation at Halifax being much more exposed than that at Ealing, it was soon found very desirable to put up a dome so as more effectively to protect both the instrument and the observer. The present dome was completed in 1887. It is constructed in a similar manner to the excellent dome by Messrs. Cooke of York, at the Greenwich Observatory, except so far as the covering and the shutters and some of the minor details are concerned.

The accompanying plan and section, with the following explanation, will perhaps make the construction plain.

The building is circular, the same diameter as the dome—38 ft. 9 in. outside and 36 ft. 3 in. inside. The walls are stone outside and brick inside. The circular wall is 1 ft. 3 in. thick, 7 ft. 4 in. high above the floor, and finishing with an ashlar